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Political Arithmetic and Sacred History: Population Thought in the English Enlightenment, 1660–1750

Ted McCormick

Abstract Current approaches to the history of early modern population thought focus on the state and secular governance, while standard treatments of Restoration and Augustan "political arithmetic" emphasize its economic or social-scientific content. This article recovers nonsecular uses of demographic quantification, excavating the use of political arithmetic in religious polemic between ca. 1660 and ca. 1750. As a form of empirical natural philosophy, political arithmetic suited the polemical needs of latitudinarian Anglicans and others combating deism, atheism, and preadamism; the demographic regularities it revealed furnished evidence of providential solicitude, while the history of population growth was a potential prop for scriptural chronologies. A strand of "sacred" political arithmetic thus contributed to natural theology while modeling—albeit inconsistently—new historical applications for empirical methodology. The article concludes by considering possible causes for the decline of this "sacred" strand of demographic quantification, while suggesting connections between it and better-known secular forms of Enlightenment-era population thought.

The empirical study and methodical government of populations are among the early modern period's definitive legacies to the modern. In the 1580s, Giovanni Botero described demographic knowledge as part of any effective ruler's toolkit; during the Stuart Restoration, the measurement and manipulation of problematic subpopulations became the explicit goal of William Petty's "political arithmetic."[1] In the eighteenth century, demographic concerns shaped

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[1] On Botero, see Richard Tuck, *Philosophy and Government, 1572–1651* (Cambridge, 1993), 81, and Romain Descendre, *L'État du monde: Giovanni Botero entre raison d'État et géopolitique* (Geneva, 2009); on Petty, Sabine Reungoat, *William Petty: Observateur des Îles Britanniques* (Paris, 2004), and Ted McCormick, *William Petty and the Ambitions of Political Arithmetic* (Oxford, 2009). See also Peter Buck, "Seventeenth-Century Political Arithmetic: Civil Strife and Vital Statistics," *Isis* 68, no. 1 (March 1977): 67–84; Peter Buck, "People Who Counted: Political Arithmetic in the Eighteenth Century," *Isis* 73, no. 1 (March 1982): 28–45; Ian Hacking, *The Emergence of Probability: A Philosophical Study of Early Ideas about Probability, Induction and Statistical Inference*, 2nd ed. (Cambridge, 2006), 102–10; Julian Hoppit, "Political Arithmetic in Eighteenth-Century England," *Economic History Review* 49, no. 3 (August 1996): 516–40; Paul Slack, "Government and Information in Seventeenth-Century England," *Past and Present* 184 (August 2004): 33–68; Paul Slack, "Measuring the National Wealth in Seventeenth-Century England," *Economic History Review* 57, no. 4 (November 2004): 607–35; Paul Slack, *"Plenty of People": Perceptions of Population in Early Modern England* (Reading, 2011).

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projects of social engineering, empire building, and economic "improvement," while a new demographic awareness encouraged popular agency in family limitation.[2] Whether tied to the creation of scientific economics, state formation, or the rise of modern governmentality, the emergence of population as the preeminent object of political knowledge and action, and of life itself as an object of individual and collective management, was central to Enlightenment conceptualizations of society and governance, and to the experience of power.[3]

As the intellectual history of population has fueled explanations of modernity, modern disciplinary models have constrained views of early modern demographic thought.[4] Thus the quantitative demographic discourse of political arithmetic, pioneered during the Restoration by John Graunt and William Petty, becomes a

[2] See George Louis Beer, *The Origins of the British Colonial System, 1578–1660* (1908; rpr. Gloucester, 1959), 32–53; Edgar S. Furniss, *The Position of the Laborer in a System of Nationalism: A Study in the Labor Theories of the Later English Mercantilists* (1918; rpr. New York, 1965); compare Mildred Campbell, "'Of People Either Too Few or Too Many': The Conflict of Opinion on Population and Its Relation to Emigration," in *Conflict in Stuart England: Essays in Honour of Wallace Notestein*, ed. William Appleton Aiken and Basil Duke Henning (London, 1960), 169–201; James H. Cassedy, *Demography in America: Beginnings of the Statistical Mind, 1600–1800* (Cambridge, MA, 1969); D. V. Glass, *Numbering the People: The Eighteenth-Century Population Controversy and the Development of Census and Vital Statistics in Britain* (Farnborough, 1973); Joyce Appleby, *Economic Thought and Ideology in Seventeenth-Century England* (Princeton, 1978), 129–57. See also Daniel Statt, *Foreigners and Englishmen: The Controversy Over Immigration and Population, 1660–1760* (Newark, DE, 1995); Carol Blum, *Strength in Numbers: Population, Reproduction, and Power in Eighteenth-Century France* (Baltimore, 2002); Andrea Rusnock, *Vital Accounts: Quantifying Health and Population in Eighteenth-Century England and France* (Cambridge, 2002); Charlotte Sussman, "The Colonial Afterlife of Political Arithmetic: Swift, Demography, and Mobile Populations," *Cultural Critique* 56 (Winter 2004): 96–126; Sarah Barber, "Settlement, Transplantation and Expulsion: A Comparative Study of the Placement of Peoples," in *British Interventions in Early Modern Ireland*, ed. Ciaran Brady and Jane Ohlmeyer (Cambridge, 2005), 280–98; Lisa Forman Cody, *Birthing the Nation: Sex, Science, and the Conception of Eighteenth-Century Britons* (Oxford, 2005); Susan E. Klepp, *Revolutionary Conceptions: Women, Fertility, and Family Limitation in America, 1760–1820* (Chapel Hill, 2009); Leslie Tuttle, *Conceiving the Old Regime: Pronatalism and the Politics of Reproduction in Early Modern France* (Oxford, 2010).

[3] See William Letwin, *The Origins of Scientific Economics* (London, 1963), 123–57; R. Olson, *The Emergence of the Social Sciences, 1642–1792* (New York, 1993), 57–70; Miles Ogborn, *Spaces of Modernity: London's Geographies, 1680–1780* (New York, 1998), 158–200; see also John Brewer, *The Sinews of Power: War, Money and the English State, 1688–1783* (Cambridge, MA, 1990). On governmentality, see Michel Foucault, "Omnes et Singulatim: Towards a Criticism of Political Reason," Tanner Lectures on Human Values, Stanford University, 10 and 16 October 1979, in *Religion and Culture*, ed. Jeremy R. Carrette (New York, 1999), 135–52, and "Governmentality," in *The Foucault Effect: Studies in Governmentality*, ed. Graham Burchell, Colin Gordon, and Peter Miller (Chicago, 1991), 87–104; see also Patrick Carroll, *Science, Culture, and Modern State Formation* (Berkeley, 2006), 113–42. On Enlightenment population debates, see Sylvana Tomaselli, "Moral Philosophy and Population Questions in Eighteenth Century Europe," *Population and Development Review* 14, Supplement (1988): 7–29, and "Political Economy: The Desire and Needs of Present and Future Generations," in *Inventing Human Science: Eighteenth-Century Domains*, ed. Christopher Fox, Roy Porter, and Robert Wokler (Berkeley, 1995), 292–322.

[4] Charles Emil Strangeland, *Pre-Malthusian Doctrines of Population: A Study in the History of Economic Theory* (New York, 1904); James Bonar, *Theories of Population: From Raleigh to Arthur Young* (1929; rpr. London, 1992); E. A. J. Johnson, *Predecessors of Adam Smith: The Growth of British Economic Thought* (New York, 1937); E. P. Hutchinson, *The Population Debate: The Development of Conflicting Theories Up to 1900* (New York, 1967); Johannes Overbeek, *History of Population Theories* (Rotterdam, 1974); Terence Hutchison, *Changing Aims in Economics* (Oxford, 1992), 1–5. Compare Quentin Skinner, "Meaning and Understanding in the History of Ideas," in *Visions of Politics I: Regarding Method* (Cambridge, 2002), 57–89; Keith Tribe, *Land, Labour and Economic Discourse* (London, 1978), 5–23; Philip

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species of "political economy." Its construction of population is assumed to resemble that of modern social science: a secular engagement, concerned with using statistics to calibrate policy in the interests of wealth or growth.[5] The reduction of "population" in an English discursive context to a thinly veiled concept of labor undergirds accounts of the rise of a commercial mind-set in the later seventeenth century, its domestic triumph in the Revolution of 1688–89, and its achievement of hegemonic status in the generations thereafter.[6] Yet placing the quantitative, empirical study of population on one side of a contest between archaism and modernity (particularly if this is seen in terms of secularization) ignores much of its content and obscures what it meant to most of those who produced, consumed, and rearticulated it.

A quantitative approach to population helped orient political and social thought to new problems of wealth and power during the long eighteenth century. At the same time, political economy came to function as a "platform" for Enlightenment.[7] But political economy was not the only avenue by which demographic quantification entered the Enlightenment, and its concerns did not always set the terms for the encounter. Many political economists, indeed, regarded political arithmetic as an occupation distinctly inferior to their own; Adam Smith used it as a source of data, but he expressed "no great faith" in its accuracy.[8] More recently, Mary Poovey has emphasized the distinction between moral philosophy, from which political economy derived, and *police*, the older "science of government" to which she argues political arithmetic belonged.[9] However, this genealogy obscures as much as it reveals. Starting in the 1660s and continuing through its "golden age" under William III and Anne, political arithmetic found a number of religious uses.[10] In particular, it played highly visible roles in "physico-theology," the attempt to

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Kreager, "Histories of Demography: A Review Article," *Population Studies* 47, no. 3 (November 1993): 519–39.

[5] Phyllis Dean, *The State and the Economic System: An Introduction to the History of Political Economy* (Oxford, 1989), 23; Lars Magnusson, *Mercantilism: The Shaping of an Economic Language* (Abingdon, 1994), 131; John A. Taylor, *British Empiricism and Early Political Economy: Gregory King's 1696 Estimates of National Wealth and Population* (Westport, CT, 2005). Compare Andrea Finkelstein, *Harmony and the Balance: An Intellectual History of Seventeenth-Century English Economic Thought* (Ann Arbor, 2000).

[6] See Steve Pincus, "From Holy Cause to Economic Interest: The Study of Population and the Invention of the State," in *A Nation Transformed: England After the Restoration*, ed. Alan Houston and Steve Pincus (Cambridge, 2001), 272–98; Steve Pincus, *1688: The First Modern Revolution* (New Haven, 2009). See also Sophus Reinert, *Translating Empire: Emulation and the Origins of Political Economy* (Cambridge, MA, 2011).

[7] John Robertson, *The Case for Enlightenment: Scotland and Naples, 1680–1760* (Cambridge, 2005), 325–76. See also Istvan Hont, *Jealousy of Trade: International Competition and the Nation-State in Historical Perspective* (Cambridge, MA, 2005), 1–156.

[8] Adam Smith, *An Inquiry into the Nature and Causes of the Wealth of Nations*, 2 vols. (London, 1776), 2:121; Donald Winch, *Riches and Poverty: An Intellectual History of Political Economy in Britain, 1750–1834* (Cambridge, 1996), 103.

[9] Mary Poovey, "Between Political Arithmetic and Political Economy," in *Regimes of Description: In the Archive of the Eighteenth Century*, ed. John Bender and Michael Marrinan (Stanford, 2005), 61–76. See also Michael Donnelly, "From Political Arithmetic to Social Statistics: How Some Nineteenth-Century Roots of the Social Sciences Were Implanted," in *The Rise of the Social Sciences and the Formation of Modernity: Conceptual Change in Context, 1750–1850*, ed. Johan Heilbron, Lars Magnusson, and Björn Wittrock (Dordrecht, 1998), 225–39.

[10] Hoppit, "Political Arithmetic," 516–17; Taylor, *British Empiricism*, 83.

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demonstrate God's providence through the empirical study of nature, and to debates about the historical and natural-philosophical plausibility of the book of Genesis.[11]

What one might call "sacred" political arithmetic dealt not with the management of labor or revenues but with evidence of divine government and the "oeconomy" of creation. It said less, in the first instance, about the secular present or future than about the ancient and scriptural past. It was the instrument not of bureaucrats or projectors but of natural philosophers, scholars, and clergymen—specifically, latitudinarian Anglicans and like-minded defenders of scripture and providence against the challenges of deism, preadamism, eternalism, and materialism. This is not to suggest that "religious" users of demographic quantification presented a united front. Different authors favored different texts of scripture and therefore different chronologies of sacred history. Among them were at least one High Churchman, a larger number of more or less heterodox Arians or anti-Trinitarians, and a handful of scientifically inclined New England Congregationalists. What they shared was a commitment to securing a scriptural worldview by rational means, establishing that a short chronology and a providentialist interpretation of nature and history could withstand the scientific scrutiny political arithmetic made possible—and, thereby, the skeptical assaults of deists and atheists. Alert to the epistemological promise of this new "art of reasoning," they reaped its benefits outside the realm of modern social science.

Sacred political arithmetic was more than an archaic curiosity. In applying empirical demographic observations to the distant past in order to frame natural explanations of scriptural claims, latitudinarian and allied users of political arithmetic implied the commensurability of past and present. They thereby intimated a shift in ideas of historiographical plausibility often associated with the very "radical Enlightenment" against which their efforts were bent.[12] Jed Buchwald and Mordechai Feingold have traced the role of population in Isaac Newton's historical research, which they argue yielded a new idea of civilization itself.[13] Yet even before this, and for a long time afterward, Anglican apologists probed the historical and religious implications of empirical demographic observations. More timid than Newton and less worldly than political economy, their cautious and selective engagements with demographic quantification better represent what population meant to a literate, moderate, Protestant English mainstream—a mainstream to which most "secular" political arithmeticians belonged.

Like the discourse of physico-theology and early theories of geohistory to which it sometimes contributed, sacred political arithmetic was radical more by implication

[11] Jean-Marc Rohrbasser, "William Petty (1623–1687) et le calcul du doublement de la population," *Population* 54, nos. 4–5 (July–October 1999): 693–705; Justus Nipperdey, "Johann Peter Süssmilch: From Divine Law to Human Intervention," *Population* [English edition] 66, no. 3 (May 2011): 611–36.

[12] See Richard H. Popkin, *Isaac La Peyrère (1596–1676): His Life, Work and Influence* (Leiden, 1987); J. A. I. Champion, *The Pillars of Priestcraft Shaken: The Church of England and Its Enemies, 1660–1730* (Cambridge, 1992); Jonathan Israel, *Radical Enlightenment: Philosophy and the Making of Modernity, 1650–1750* (Oxford, 2001); Noel Malcolm, "Hobbes, Ezra, and the Bible: The History of a Subversive Idea," in *Aspects of Hobbes* (Oxford, 2002), 383–431; Colin Kidd, *The Forging of Races: Race and Scripture in the Protestant Atlantic World, 1600–2000* (Cambridge, 2006), 54–78; Davin N. Livingstone, *Adam's Ancestors: Race, Religion and the Politics of Human Origins* (Baltimore, 2008).

[13] Jed Z. Buchwald and Mordechai Feingold, *Newton and the Origin of Civilization* (Princeton, 2013), 164–94.

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than by design.[14] Nevertheless, in making empirical observation and naturalistic explanation into exegetical principles, however partially or hesitantly, it formed part of the remodeling of cognitive values identified by Stephen Gaukroger as the key to the Enlightenment and the "emergence of scientific culture."[15] Like physico-theology, it was primarily a Protestant, and an English, endeavor—in contrast to state or economically oriented applications of demographic statistics.[16] It took shape within a distinctively English culture of demographic data gathering, centering on London's printed bills of mortality and the registration duties of the Anglican parish priest.[17] It was a specifically English fusion of theological apologetic and empirical science, effected by political arithmetic's own inventors and their Anglican readers in the decades following the Restoration and the formation of the Royal Society.[18]

Sacred political arithmetic sheds light on what historians of science have described as a "latitudinarian" deployment of probabilistic reasoning, natural law, and empirical method against deism, religious "enthusiasm," and hierocratic authoritarianism.[19] The "latitudinarian" label has been criticized, but an alternative formulation such as "Anglican rationalism"—entailing "the reasonableness of scripture and the general availability of its fundamental, saving truths to the plain sense of all readers"—captures what was at stake.[20] It seems clear, however, that certain

[14] William Poole, *The World Makers: Scientists of the Restoration and the Search for the Origins of the Earth* (Oxford, 2010), 5–6, 55–74; Martin J. S. Rudwick, "The Shape and Meaning of Earth History," in *God and Nature: Historical Essays on the Encounter between Religion and Science*, ed. David C. Lindberg and Ronald L. Numbers (Berkeley, 1986), 306. See also Roy Porter, *The Making of Geology: Earth Science in Britain, 1660–1815* (Cambridge, 1977), 62–90; Paolo Rossi, *The Dark Abyss of Time: The History of the Earth and the History of Nations from Hooke to Vico*, trans. Lydia G. Cochrane (Chicago, 1984); J. G. A. Pocock, "Within the Margins: The Definition of Orthodoxy," in *The Margins of Orthodoxy: Heterodox Writing and Cultural Response, 1660–1750*, ed. Roger D. Lund (Cambridge, 1995), 33–53; Rhoda Rappaport, *When Geologists Were Historians, 1665–1750* (Ithaca, 1997).

[15] Stephen Gaukroger, *The Collapse of Mechanism and the Rise of Sensibility: Science and the Shaping of Modernity, 1680–1760* (Oxford, 2010), 1–8; Peter Harrison, *The Bible, Protestantism, and the Rise of Natural Science* (Cambridge, 1998), 266–73.

[16] Gaukroger, *Collapse*, 1–8, 32–34; Nipperdey, "Johann Peter Süssmilch." A recent collection of essays on French political arithmetic touches on physico-theology only in reference to Süssmilch. Bernard Bru, "De la physico-théologie démographique à la physique statistique," in *Arithmétique Politique dans la France du XVIIIe Siècle*, ed. Thierry Martin (Paris, 2003), 71–88.

[17] A review of Graunt's work in the *Journal des Sçavans* 31 (1666): 359–70, noted (359): "C'est une chose particuliere aux Anglois de faire des *Billets de mortalité*, c'est à dire des listes qui contiennent combien il naist de personne chaque semaine, combien il en meurt, & quelle est la cause de leur mort." See Mark S. R. Jenner, "Plague on a Page: *Lord Have Mercy Upon Us* in Early Modern London," *Seventeenth Century* 27, no. 3 (Autumn 2012): 255–86; Simon Szreter, "Registration of Identities in Early Modern English Parishes and Amongst the English Overseas," in *Registration and Recognition: Documenting the Person in World History*, ed. Keith Breckinridge and Simon Szreter, *Proceedings of the British Academy* 182 (2012): 67–92.

[18] Barbara Shapiro, "Early Modern Intellectual Life: Humanism, Religion and Science in Seventeenth Century England," *History of Science* 29, no. 1 (March 1991): 45–71; Barbara Shapiro, "Natural Philosophy and Political Periodization: Interregnum, Restoration and Revolution," in Pincus and Houston, *A Nation Transformed: England After the Restoration*, 299–327.

[19] Margaret C. Jacob, *The Newtonians and the English Revolution, 1689–1720* (Ithaca, 1976).

[20] William Gibson, *The Church of England, 1688–1832: Unity and Accord* (London, 2001), 1–3; Brent S. Sirota, "The Trinitarian Crisis in Church and State: Religious Controversy and the Making of the Post-revolutionary Church of England, 1687–1702," *Journal of British Studies* 52, no. 1 (January 2013): 32–33.

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demographic arguments circulated among clerics and laymen who shared links with reputed latitudinarian figures, Low Church views, and empiricist methodological commitments; expositions of this sacred political arithmetic frequently occurred in venues, such as the Boyle Lectures, that showcased stereotypically latitudinarian ideas.[21] Sacred political arithmetic bears out the idea of a clerical Enlightenment shaped by the values and beliefs of seventeenth-century latitudinarian theologians and natural philosophers.[22] Conversely, political arithmetic's latitudinarian appeal helps explain its adoption by New England Puritans drawn to the theology of John Tillotson, the science of the Royal Society, and Whig ideas of Protestant empire.[23]

More than simply suggesting that religious uses of demographic quantification had political implications, however, excavating sacred political arithmetic puts secular statistics and its public profile in a different light. First, it suggests that providential interpretations and scriptural allusions should not be dismissed as extraneous bits of period dress. Second, it reminds us that while both sacred and secular works publicized new thinking about population, the former likely played the more prominent role. The "golden age" of political arithmetic was also that of the sermon, and it was through the latter that demographic claims probably reached the largest audiences.[24] Far more people read William Derham's *Physico-Theology* than ever picked up Charles Davenant's *Discourses on the Publick Revenues*; as late as 1750, sacred history was still part of the intellectual mainstream.[25] The religious dimension of seventeenth- and eighteenth-century demographic thought can be dismissed only at the cost of obscuring what population meant to most of the people who wrote, read, and thought about it at the time.

All this suggests, finally, that sacred political arithmetic has implications for our understanding of the "modernity" of the Enlightenment itself. Most current literature traces substantive developments in demographic thinking to operational (or, in Foucault's formulation, "biopolitical") contexts, wherein population became an

[21] See, however, Richard G. Olson, "Tory-High Church Opposition to Science and Scientism in the Eighteenth Century: The Works of John Arbuthnot, Jonathan Swift, and Samuel Johnson," in *The Uses of Science in the Age of Newton*, ed. John G. Burke (Berkeley, 1983), 171–204.

[22] B. W. Young, *Religion and Enlightenment in Eighteenth-Century England: Theological Debate from Locke to Burke* (Oxford, 1998); J. G. A. Pocock, *Barbarism and Religion*, 5 vols. (Cambridge, 1999–2011), 1:13–49; B. W. Young, "The Union in British History," in *The Discovery of Islands: Essays in British History* (Cambridge, 2005), 174. See also John Redwood, *Reason, Ridicule and Religion: The Age of Enlightenment in England, 1660–1750* (London, 1976); Jane Shaw, *Miracles in Enlightenment England* (New Haven, 2006); David Sorkin, *The Religious Enlightenment: Protestants, Jews, and Catholics From London to Vienna* (Princeton, 2008).

[23] See Michael P. Winship, *Seers of God: Puritan Providentialism in the Restoration and Early Enlightenment* (Baltimore, 1996), 74–110; Ned C. Landsman, *From Colonials to Provincials: American Thought and Culture, 1680–1760* (Ithaca, 1997), 63–70; Thomas S. Kidd, *The Protestant Interest: New England after Puritanism* (New Haven, 2004); Jeremy Gregory, "Refashioning Puritan New England: The Church of England in British North America, *c.* 1680–*c.* 1770," *Transactions of the Royal Historical Society* 20 (2010): 85–112.

[24] Tony Claydon, "Daily News and the Construction of Time in Late Stuart England, 1695–1714," *Journal of British Studies* 52, no. 1 (January 2013): 58.

[25] Thomas R. Preston, "Biblical Criticism, Literature, and the Eighteenth-Century Reader," in *Books and Their Readers in Eighteenth-Century England*, ed. Isabel Rivers (New York, 1982), 97–126; R. J. Arnold, "'Learned Lumber': The Unlikely Survival of Sacred History in the Eighteenth Century," *English Historical Review* 125, no. 516 (October 2010): 1139–72.

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object of knowledge and management at once—for example, a labor pool, a target of disease, or an army.[26] In such accounts, religion appears either as an ideological hindrance to the progress of enumeration (as with references to the biblical prohibition on census taking) or else as the archaic source of certain features of the modern state (as in Foucault's idea of "pastoral power").[27] Neither theology nor the church has been granted an active role in population's emergence as a scientific and political object. Yet until the nineteenth century, churches, and the Church of England in particular, were crucial gatherers and repositories of demographic information.[28] Clergymen were prominent public interpreters of this information; they gave ideas about population polemical currency as well as practical, pastoral force.

Population attracted new political and scientific attention during the long eighteenth century, but the example of political arithmetic suggests that this could happen through, not in spite of, religious commitments. Discussions of sacred history provided space for the elaboration of "natural" ideas about population, as governed by laws and constrained by the environment; the use of these ideas in establishing the plausibility of historical claims reflected a cognitive shift fundamental for later Enlightenment reconstructions of the past. Providential interpretations of demographic data persisted longer still. Midcentury medical arithmeticians still ascribed moral significance to the course of epidemics. Indeed, as A. M. C. Waterman and Donald Winch have shown, demographic providentialism colored Malthus's *Essay on the Principle of Population*.[29] From the Stuart Restoration to the Age of Revolutions, in short, population retained a sacred as well as a secular meaning. Almost from its inception, political arithmetic promised access to both.

■■■

William Petty coined the phrase "political arithmetic" around 1670. He applied it to a host of works, many focused on the government of quantifiable groups: idle laborers, colonial settlers, and notoriously the Irish, whom (as the owner of extensive Irish estates) he sought to render industrious and loyal by means of an ambitious program of social engineering.[30] Petty's contemporaries retrospectively affixed the

[26] See Thierry Martin, "Introduction: Une arithmétique politique française?" and Robert Damien, "Prolégomènes français à une science politique future: Vauban, Lavoisier, Volney, Neufchâteau, Chaptal," in *Arithmétique Politique dans la France du XVIIIe Siècle*, ed. Thierry Martin (Paris, 2004), 1–13 and 17–34, respectively. Compare Slack, "Plenty of People"; J. C. D. Clark, "Providence, Predestination and Progress: Or, Did the Enlightenment Fail?" *Albion: A Quarterly Journal Concerned with British Studies* 35, no. 4 (Winter 2003): 559–89.

[27] In 1 Chronicles 21:1 (King James Version), "Satan stood up against Israel, and provoked David to number" the people; see also 2 Samuel 24:10. See Damien, "Prolégomènes"; Patricia Cline Cohen, *A Calculating People: The Spread of Numeracy in Early America* (Chicago, 1982), 35; Kathrin Levitan, *A Cultural History of the British Census: Envisioning the Multitude in the Nineteenth Century* (New York, 2011), 181; Foucault, "Omnes."

[28] The first British national census was taken in 1801; civil registration supplanted parish registers from 1836. Szreter, "Registration," 88–91.

[29] A. M. C. Waterman, *Revolution, Economics and Religion: Christian Political Economy, 1798–1833* (Cambridge, 1991); Winch, *Riches*, 221–405.

[30] William Petty, *Political Arithmetick* (London, 1690), *The Political Anatomy of Ireland* (London, 1691), and *Several Essays in Political Arithmetick* (London, 1699). See Frances Harris, "Ireland As a Laboratory: The Archive of Sir William Petty," in *Archives of the Scientific Revolution: The Formation and Exchange of Ideas in Seventeenth-Century Europe*, ed. Michael Hunter (Woodbridge, 1998), 73–90; Tony

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same label to the work of his friend, tradesman and fellow of the Royal Society John Graunt, whose 1662 *Natural and Political Observations . . . upon the Bills of Mortality* came to be seen as the genre's founding text (partly for this reason, it was often misattributed to Petty).[31] Graunt's analysis of the London bills led him to conclusions about plague measures, social and economic policy, and the comparative salubrity of city and country. Both men aimed, in a Baconian vein, to be useful.[32] Their best-known successors after 1688 cemented political arithmetic's secular legacy. Gregory King tabulated those parts of the population increasing and those decreasing the wealth of the kingdom.[33] Charles Davenant, using King's numbers, authored a shelf of economic and political works, becoming "probably the most influential English analyst of trade" of his time.[34] He also penned the pithiest and arguably the most influential definition of political arithmetic, as "the Art of Reasoning, by Figures, upon Things relating to Government."[35] Perhaps most significantly, the polymath Edmund Halley used mortality bills from Breslau (Wrocław) to construct a "life table," giving the probability of an individual's survival to a given age and initiating a long series of refinements in the calculation of annuities.[36] These men confirmed political arithmetic's profile as a proto-statistical demography meant for concrete, secular uses.[37]

Aspromourgos, "The Mind of the Oeconomist: An Overview of the 'Petty Papers' Archive," *History of Economic Ideas* 9, no. 1 (2001): 39–102; McCormick, *Petty*, 6–8, 259–84.

[31] John Graunt, *Natural and Political Observations, Mentioned in a Following Index, and Made upon the Bills of Mortality* (London, 1662). Hervé Le Bras, *Naissance de la mortalité: L'origine politique de la statistique et de la mortalité* (Paris, 2000), assigns principal authorship to Petty, but most scholars disagree. See McCormick, *Petty*, 131–32.

[32] Graunt, *Observations*, sig. A3v; Petty, *Political Anatomy*, sig. A5r; McCormick, *Petty*, 40–83.

[33] See "'The LCC Burns Journal': A Manuscript Notebook Containing Workings for Several Projected Works," in *The Earliest Classics: John Graunt and Gregory King*, ed. Peter Laslett (Farnborough, 1973). King's table appeared as "Scheme D" in Charles Davenant, *An Essay upon the Probable Methods of Making a People Gainers in the Ballance of Trade* (London, 1699), between pages 22 and 23. See Taylor, *British Empiricism*; Geoffrey Holmes, "Gregory King and the Social Structure of Pre-Industrial England," in *Politics, Religion and Society in England, 1679–1742* (London, 1986), 281–308.

[34] Hont, *Jealousy*, 201; D. A. G. Waddell, "The Career and Writings of Charles Davenant (1656–1714)" (DPhil diss., Oxford University, 1954); J. G. A. Pocock, *The Machiavellian Moment: Florentine Political Thought and the Atlantic Republican Tradition* (Princeton, 1975), 423–61.

[35] Charles Davenant, *Discourses on the Publick Revenues, and On the Trade of England* (London, 1698), 2. Aubrey, discussing James Harrington's Rota Club, described Petty's "reducing politics to numbers"; John Aubrey, *Brief Lives*, ed. Richard Barber (Woodbridge, 1982), 247.

[36] Edmund Halley, "An Estimate of the Degrees of the Mortality of Mankind, Drawn from Curious Tables of the Births and Funerals at the City of Breslaw," *Philosophical Transactions of the Royal Society* [hereafter *PTRS*] 17 (1693): 596–610.

[37] Andrea Rusnock, "Biopolitics: Political Arithmetic in the Enlightenment," in *The Sciences in Enlightened Europe*, ed. William Clark, Jan Golinski, and Simon Schaffer (Chicago, 1999), 53; Hoppit, "Political Arithmetic," 517; Hacking, *Emergence*, 92–121. For political arithmetic in Europe, see Gottfried Wilhelm Leibniz, "Essay de quelques raisonnemens nouveaux sur la vie humaine et sur le nombre des hommes" [1680s?], in *Leibniz et les raisonnements sur la vie humaine*, ed. Jean-Marc Rohrbasser and Jacques Véron (Paris, 2001), 105–23; Johann Peter Süssmilch, *Die göttliche Ordnung in den Veränderungen des menschlichen Geschlechts* (Berlin, 1741); Willem Kersseboom, *Essais d'arithmétique politique, contenant trois traités sur la population de la province de Hollande et Frise Occidentale* [1742] (Paris, 1970); Antoine Deparcieux, *Essai sur les Probabilités de la Durée de la Vie Humaine* (Paris, 1746); Pehr Wargentin, *Tables of Mortality based upon the Swedish Population in 1766* (Stockholm, 1930).

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Yet despite Petty's influential (biblical) rhetoric of "number, weight and measure," political arithmetic did not create the "information state."[38] On the one hand, this was because the necessary "avalanche of numbers," such as national census data, lay far in the future.[39] On the other hand, the kinds of information that Graunt and Petty used were generations old when they wrote. Bills of mortality began during sixteenth-century plague outbreaks and had been printed continuously since 1603; enshrined in popular broadsheets from the 1620s onward, they also featured in Samuel Pepys's firsthand and Daniel Defoe's fictionalized accounts of the 1665 epidemic.[40] Registers of baptisms, marriages, and burials—the other blue chip source of population data—had been made the responsibility of parish clergy by Thomas Cromwell in 1538.[41] Both had faults: spottiness and the omission of dissenters compromised registers, while Graunt blamed inexpert "searchers" for mistaken causes of death in the mortality bills.[42] What was novel about political arithmetic was not the scope or accuracy of demographic information but the framework within which it had value. This framework came from natural philosophy.

The natural-philosophical roots of political arithmetic are not unknown. Baconian inductivism, Cartesian physico-mathematics, Boyle's matter theory, and Hobbes's ideas about geometrical demonstration all feature in histories of economics and studies of Petty in particular.[43] However, neither the nature of such connections nor their implications for political arithmetic's reception have been fully appreciated. Natural philosophy was not simply a source of methodological inspiration or scientific rhetoric. Petty's "transmutation" of the Irish, for example, applied a corpuscularian reading of alchemical change directly to human populations, treating individuals as atoms and families as corpuscles; if new kinds of people were introduced in the right proportions, Petty suggested, the population's qualities would change with the same necessity as any other material.[44] Similarly, when Graunt gathered the mortality bills, took "a view of the whole together," and applied his "Shop-Arithmetique"

[38] See Petty, *Political Arithmetick*, sig. A4r; compare Wisdom of Solomon (Apocrypha), 11:20. See Edward Higgs, *The Information State in England: The Central Collection of Information on Citizens Since 1500* (Basingstoke, 2004).

[39] Ian Hacking, *The Taming of Chance* (Cambridge, 1990), 118; Donnelly, "Political Arithmetic," 231; Levitan, *British Census*. Compare Sussman, "Colonial Afterlife," 101–04.

[40] Rusnock, *Vital Accounts*, 19–24; Jenner, "Plague"; John Warrington, ed., *The Diary of Samuel Pepys*, 3 vols. (London, 1953), 2:116–65; Daniel Defoe, *A Journal of the Plague Year* (Mineola, 2001), 154–55. See Graunt, *Observations*, 4–7.

[41] Szreter, "Registration." On American colonial practice, see S. Shapiro, "Development of Birth Registration and Birth Statistics in the United States," *Population Studies* 4, no. 1 (June 1950): 86–111; Robert Gutman, "Birth and Death Registration in Massachusetts: I. The Colonial Background, 1639–1800," *Milbank Memorial Fund Quarterly* 36, no. 4 (October 1958): 58–74; Cassedy, *Demography*, 16–19; Susan E. Klepp, *"The Swift Progress of Population": A Documentary Study of Philadelphia's Growth, 1642–1859* (Philadelphia, 1991), 3–15.

[42] Graunt, *Observations*, 13–15. See also Thomas Birch, *A Collection of the Yearly Bills of Mortality, from 1657 to 1758 inclusive* (London, 1759), 4–7.

[43] See, for example, Finkelstein, *Harmony*; Mary Poovey, *A History of the Modern Fact: Problems of Knowledge in the Sciences of Wealth and Society* (Chicago, 1998), 92–143; Quentin Skinner, "Thomas Hobbes and His Disciples in France and England," *Comparative Studies in Society and History* 8, no. 2 (January 1966): 153–67.

[44] McCormick, *Petty*, 168–258.

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to the resulting data, he was not proposing a "social" science analogous to "natural" science but conducting a "Natural History" in exactly the same terms as "those Noble Virtuosi of Gresham-Colledge [i.e., the Royal Society] (who reduce their subtle Disquisitions upon Nature into downright Mechanical Uses)."[45] Political arithmetic was applied natural philosophy.

More specifically, it was a form of Baconian natural history, something Graunt and Petty both likely encountered through the Protestant "intelligencer" Samuel Hartlib and his circle in the 1640s.[46] For Hartlibians like Gerard Boate, author of *Irelands Naturall History* (which Petty was invited to complete and which his 1655–56 "Down Survey" of Ireland superseded), natural history geared empirical observations to both the advancement of learning and the productive "improvement" of nature, whether by scientific, economic, or political means.[47] Answering the Cambridge Platonist Henry More's criticism of the Hartlibians, Petty himself espoused a vision of philosophy grounded in the compilation of natural histories, which he preferred to the "Vaporous garlick & Onions" of more speculative philosophy.[48] When they later turned their attention to population, both Graunt and Petty cited Bacon's proposed "History of Life and Death"—listed at the end of *The New Organon* as one of several "Histories of Man" to be pursued experimentally—as a model.[49] It was from this model that political arithmetic's intellectual and operational power derived.

While this extension of empiricism to the social sphere foreshadowed the Enlightenment "Science of Man," its more immediate effect was to involve demographic observation in religious disputes.[50] Political arithmetic impinged on questions of belief by reason of its very object. Even as individual populations came to be conceived of as totalities governed by laws and susceptible to knowledge and intervention, population remained a global, historical process. The multiplication of mankind was, from an orthodox point of view, as unitary and as old as the earth itself.[51] The rules governing population were not simply tools for the sovereign but part of the structure of history, instruments of providence; the history of population was embedded in an authoritative, universal genealogy, from Adam, to Noah,

[45] Graunt, *Observations*, sig. A3v, 2.

[46] McCormick, *Petty*, 40–83.

[47] Gerard Boate, *Irelands Naturall History* (London, 1657), sig. A3r–A3v. See Toby Barnard, "The Hartlib Circle and the Cult and Culture of Improvement in Ireland," in *Samuel Hartlib and the Universal Reformation: Studies in Intellectual Communication*, ed. Mark Greengrass, Michael Leslie, and Timothy Raylor (Cambridge, 1994), 281–97; Adam Fox, "Printed Questionnaires, Research Networks, and the Discovery of the British Isles, 1650–1800," *Historical Journal* 53, no. 3 (September 2010): 593–621.

[48] William Petty to Samuel Hartlib [early 1649], *Hartlib Papers: A Complete Text and Image Database of the Papers of Samuel Hartlib (c. 1600–62)*, 2nd ed. on CD-ROM (Sheffield, 2002), 7/123/2a.

[49] Francis Bacon, *The New Organon*, ed. Lisa Jardine and Michael Silverthorne (Cambridge, 2000), 235–36; Graunt, *Observations*, sig. A3v; William Petty, "Materialls for a New History of Life & death," Add. MS 72897, ff. 157–58v, British Library, printed in Marquis of Lansdowne [H. W. E. Petty-Fitzmaurice] (ed.), *The Petty Papers: Some Unpublished Writings of Sir William Petty*, 2 vols. (London, 1927), 1:18–89. See also Barbara Shapiro, "Empiricism and English Political Thought, 1550–1720," *Eighteenth-Century Thought* 1 (2003): 1–33; Ted McCormick, "Governing Model Populations: Queries, Quantification, and William Petty's 'Scale of Salubrity,'" *History of Science* 51, no. 2 (June 2013): 179–98.

[50] David Hume, *A Treatise of Human Nature*, 3 vols. (London, 1739), 1:4.

[51] Dan Smail, "In the Grip of Sacred History," *American Historical Review* 110, no. 5 (December 2005): 1343.

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to Noah's progeny.[52] When political arithmetic appeared, further, both providence and scripture were under attack from philosophical quarters close to those from which it had sprung. Its entanglement in these questions was inevitable and fraught.

Since the Renaissance, the authority of the book of Genesis and the short chronology its account of early history required had faced a series of challenges.[53] The New World was one: why did scripture have nothing to say about its inhabitants or their origins?[54] Encounters with other non-European cultures—Egyptian, Near Eastern, Indian, and Chinese—posed further difficulties, exacerbated by the written historical records these civilizations could boast. How could their impressive chronologies be reconciled with the biblical timeline?[55] How could the cities and empires of the East have arisen within years of the Great Flood, which only eight people—Noah, his three sons, and their wives—had survived?[56] Looming behind many such questions was the legacy of humanism: historical criticism in the mid-seventeenth century turned upon the Bible, and in particular the Pentateuch. At the hands of Hobbes, Spinoza, La Peyrère, and Richard Simon, scripture was historicized, its inconsistencies exposed, and its authorship and plausibility put in doubt.[57]

Biblical chronology itself was no simple matter. Interpreting texts was one thing, while accommodating the resulting data to the historical record was another. In *De emendatione temporum* (1583), the Huguenot scholar Joseph Scaliger used the Julian period as a framework for bringing together classical and sacred history, dating Creation to 3949 BCE; in the mid-seventeenth century, James Ussher, archbishop of Armagh, calculated that time had begun instead on the evening before 23 October 4004 BCE.[58] By that point, over a dozen such dates had appeared, and they would multiply as attention shifted from technical details to the exigencies of religious polemic. Another challenge was the position of events within sacred history. Different versions of the Old Testament—including the Hebrew Masoretic text, the Greek Septuagint, and a recently discovered Samaritan translation—differed significantly on the time elapsed between Creation and the Flood (1656 years in the Masoretic text, 2242 in the Septuagint, 1556 in the Samaritan), as well as between the Flood and the birth of Abraham.[59] Choosing between them meant weighing

[52] Don Cameron Allen, *The Legend of Noah: Renaissance Rationalism in Art, Science, and Letters* (Urbana, 1963); Kidd, *Forging*, 19–78; Livingstone, *Adam's Ancestors*, 1–25.

[53] See Anthony T. Grafton, "Joseph Scaliger and Historical Chronology: The Rise and Fall of a Discipline," *History and Theory* 14, no. 2 (May 1975): 156–85; Rudwick, "Shape," 301–02.

[54] Livingstone, *Adam's Ancestors*, 1–25.

[55] Grafton, "Scaliger"; Rappaport, *Geologists*, 76–81; Rossi, *Dark Abyss*, 121–92. See also P. J. Marshall and Glyndwr Williams, *The Great Map of Mankind: British Perceptions of the World in the Age of Enlightenment* (London, 1982), 98–127.

[56] Allen, *Legend*, 66–91; Buchwald and Feingold, *Newton*, 164–94.

[57] Malcolm, "Hobbes"; Israel, *Radical Enlightenment*, 445–76; Rappaport, *Geologists*, 72–76; Popkin, *La Peyrère*.

[58] Grafton, "Scaliger," 171; James Ussher, *The Annals of the World* (London, 1658), 1. See Patrick Wyse Jackson, *The Chronologers' Quest: Episodes in the Search for the Age of the Earth* (Cambridge, 2006); Ernest A. Strathmann, "Ralegh on the Problems of Chronology," *Huntington Library Quarterly* 11, no. 2 (February 1948): 129–48; Graham Parry, *The Trophies of Time: English Antiquarians of the Seventeenth Century* (Oxford, 1995), 130–56; Alan Ford, *James Ussher: Theology, History, and Politics in Early-Modern Ireland and England* (Oxford, 2007).

[59] James Barr, "Pre-Scientific Chronology: The Bible and the Origin of the World," *Proceedings of the American Philosophical Society* 143, no. 3 (September 1999): 379–87; Jackson, *Chronologer's Quest*, 13–31.

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claims of divine inspiration against provenance and transmission histories. It also meant constraining to a more or less limited span of centuries the postdiluvian development of entire civilizations—and the populations they implied.

Population had featured in chronologists' work long before political arithmetic, but it was often in the form of problem-solving exercises in speculative multiplication: how quickly could two people reproduce, adding their children's capacity to do the same, and their grandchildren's, and so on, to produce the numbers required for universal destruction in the Flood or for the construction of known civilizations afterward? Such efforts resembled and sometimes accompanied attempts to quantify other aspects of biblical history—the dimensions and layout of the Ark, for example.[60] They could be extraordinarily complex, as scholars juggled specific demographic claims within scripture (the rapid multiplication of the Israelites in Egypt, for instance), logical presumptions about the capacity of the earth and the gradualness of increase, doctrinal requirements such as the universality of the Flood, and adherence to a particular version of scripture with its attendant chronology.[61] Such attempts made no appeal, however, to quantitative demographic data gathered in the present. Their object was not a naturalistic understanding of population that might act as a natural-historical bulwark for faith but the reconciliation of contradictory textual authorities. The biblical past was another country.

This does not detract from the inventiveness of the chronologists' arguments. In his 1596 *Chronologicarum demonstrationum libri tres*, for example, Johannes Temporarius (Jean du Temps) constructed a bar graph of postdiluvian population growth in support of the Masoretic chronology. Citing Ussher's treatment of such calculations in 1662, the latitudinarian Edward Stillingfleet, future bishop of Worcester, recalled Temporarius's hypothesis "that all of the posterity of *Noah* when they attained twenty *years* of *Age* had every year *twins*," yielding a population of 1,554,420 barely a century after the Flood.[62] Stillingfleet criticized these and similar suppositions (such as "that each of the *sons* of *Noah* had *ten sons*" or that "the *multiplication* of the *children* of *Israel* in *Egypt*," where "from 72. men in the space of 215. years there are procreated 600000," was typical), preferring to follow the Dutch critic Isaac Vossius in adopting the elongated chronology of the Septuagint.[63] Among Anglicans, this remained a minority position, for the gradual population growth it accommodated implied limited antediluvian settlement and perhaps a less-than-universal Flood; by contrast, the latitudinarian jurist Matthew Hale (who used Graunt and whose 1677 *Primitive Origination of Mankind* Petty read) cited Temporarius and seventeenth-century Jesuits Petavius (Denis Petau) and Athanasius Kircher in favor of the Hebrew text.[64]

[60] Allen, *Legend*, 71.

[61] Buchwald and Feingold, *Newton*, 164–94.

[62] Edward Stillingfleet, *Origines Sacrae; or, a Rational Account of the Grounds of Christian Faith* (London, 1662), 556. On Temporarius, see Daniel Rosenberg and Anthony Grafton, *Cartographies of Time: A History of the Timeline* (Princeton, 2010), 70–71. See also Frank N. Egerton III, "The Longevity of the Patriarchs: A Topic in the History of Demography," *Journal of the History of Ideas* 27, no. 4 (October–December 1966): 575–84.

[63] Stillingfleet, *Origines Sacrae*, 556; Buchwald and Feingold, *Newton*, 164–94. See Exodus 1.

[64] Matthew Hale, *The Primitive Origination of Mankind* (London, 1677), 145, 205–06. For Petty's judgment of Hale, see Marquis of Lansdowne, ed., *The Petty-Southwell Correspondence, 1676–1687* (London, 1928) [hereafter *PSC*], 44–48. See also Rhodri Lewis, "William Petty's Anthropology:

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Political arithmetic did not introduce quantification to these debates; nor did it inherently favor one text over another. Rather, it changed the epistemological terms on which the quantitative defense of scripture, whether by theologians or by natural philosophers, made sense.[65] The immediate context for this was Isaac La Peyrère's challenge to Genesis. La Peyrère's 1655 *Prae-Adamitae*, translated in 1656 as *Men before Adam*, focused on scriptural inconsistencies—some, such as the problem of where Cain's wife had come from, long familiar—and claimed in particular that a passage in Paul's epistle to the Romans established the existence of a pre-adamite population.[66] But La Peyrère also alleged natural arguments in defense of his interpretation. Among these was the assertion that Noah's sons and their wives could not have multiplied quickly enough after the Flood to account for the rise of empires—attested in scriptural and pagan sources—by Abraham's time. La Peyrère concluded from this that the Bible was not the history of all humankind but only of the Jews, who had been deposited by a separate creation into a world already stocked with people. The implications of such polygenism for thinking about human diversity took a long time to unfold, but its threat to orthodoxy was immediately obvious. If Adam had not been the first man, then the world was much older than scripture allowed; if the Flood was merely a local catastrophe, the world had not been repopulated from Noah's line at all.[67] Population—not just a number, but a dynamic entity whose growth was subject to natural laws (however unclear these were)—was now crucial.

■■■

Into a world teeming with "Scripture Scoffers and Prae-Adamites," as Petty called them, political arithmetic was born. Its capacity to confront these threats was clear to its creators.[68] We have seen that Graunt embraced the secular applications of demographic observation; another use, no less important, was the elucidation of providence. This was particularly evident in the sex ratio. Finding that male births tended to exceed female births "by about a thirteenth part," Graunt drew a religious conclusion: "That Christian Religion, prohibiting polygamy, is more agreeable to the Law of Nature, that is the Law of God, then Mahumetism, and others, that allow it." This was not simply a pious ejaculation in the midst of an otherwise secular discourse. On the contrary, the dispensation of providence that quantitative observation revealed was both a measuring stick and an explanation of human policy. The near balance between the sexes explained why polygamous nations were compelled to make eunuchs, an artifice Graunt compared to

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Religion, Colonialism, and the Problem of Human Diversity," *Huntington Library Quarterly* 74, no. 2 (June 2011), 261–88; Alan Cromartie, *Sir Matthew Hale, 1609–1676: Law, Religion and Natural Philosophy* (Cambridge, 1995), 137–91; "Sir Matthew Hale on the Gradual Increase of Mankind," *Population and Development Review* 36, no. 4 (December 2010): 831–39.

[65] Compare Buchwald and Feingold, *Newton*, 164–94, which stresses the difference between these groups rather than the common features of their encounter with political arithmetic.

[66] Isaac La Peyrère, *Men before Adam* (London, 1656); Isaac La Peyrère, *A Theological Systeme Upon That Presypposition, That Men Were before Adam* (London, 1655). See Romans 5:12–14.

[67] La Peyrère, *Theological Systeme*, 239–41, 248–58. See Popkin, *La Peyrère*, 115–76; Livingstone, *Adam's Ancestors*; Kidd, *Forging*, 79–167.

[68] William Petty to Robert Southwell, 20 August 1681, in *PSC*, 92.

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gelding.[69] It also established the unnaturalness of Catholic celibacy, for "if a greater number of Males oblige themselves to [be] Caelibate than the natural overplus or difference between them and Females amounts unto, then multiplication is hindered," either because too few men circulated or because women became barren through promiscuity. The natural way to encourage growth, by contrast, was by "encouraging Marriage, and hindering Liceniousness . . . [preserving] the Laws of God from contempt, and Violation."[70]

This was a guideline for government as well as a revelation of divine order, and in both respects it was one of Graunt's most influential insights. Gregory King and G. W. Leibniz agreed that the sex ratio made polygamy unnatural.[71] The Scriblerian wit John Arbuthnot made the sex ratio the basis of his "Argument for Divine Providence," printed in the *Philosophical Transactions* in 1712. He noted the advantage a natural surplus of males represented for the conduct of trade and warfare, showing "that it is Art," that is, "Divine Providence, working for a Good End," and "not Chance, that governs."[72] Continental Protestant statisticians such as Willem Kersseboom and Lutheran pastor Johann Peter Süssmilch repeated the point, as did later English medical arithmeticians.[73] (Montesquieu—and, following him, Louis de Beausobre—challenged Arbuthnot's factual claims and providentialist interpretation, arguing that polygamy might be natural in parts of Africa or Asia where climate affected the sex ratio.)[74] In his 1711–12 Boyle Lectures, published in 1714 as *Physico-Theology*, William Derham even discerned a "balance of Animals," claiming that providence governed different species' populations by imposing an inverse relationship between fecundity and lifespan, calibrated to the usefulness of each creature. Thus "by a curious Harmony, and just proportion between the increase of all Animals, and the length of their Lives," he wrote, "the World is through all Ages well, but not over-stored."[75] War, plague, and disaster might traverse the globe, yet human population as a whole continued to flourish. "[W]hat is all this," he asked, "but admirable and plain Management?"[76]

Such demographic providentialism had politico-religious implications. It seems probable, for instance, that discussions of the sex ratio formed part of the intellectual context for the Marriage Duty Act of 1695, associated with Gregory King.[77] King,

[69] Graunt, *Observations*, 47–51.

[70] Ibid., 51–52.

[71] King, "LCC Burns Journal," 101–03; Leibniz, "Essay," 121.

[72] John Arbuthnot, "An Argument for Divine Providence, Taken from the Constant Regularity Observ'd in the Births of Both Sexes," *PTRS* 27 (1712): 186–90.

[73] John Eames, "A Short Account of Mr. Kersseboom's Essay. . . upon the Number of People in Holland and West-Friezland, as Also in Harlem, Gouda and the Hague; Drawn from the Bills of Births, Burials, or Marriages, in Those Places," *PTRS* 40 (1737–38): 401; Thomas Short, *New Observations, Natural, Moral, Civil, Political, and Medical, on City, Town, and Country Bills of Mortality* (London, 1750), 180.

[74] Charles-Louis de Secondat, baron de Montesquieu, *The Spirit of the Laws*, trans. Anne M. Cohler, Basia Carolyn Miller, and Harold Samuel Stone (Cambridge, 1989), 266; Louis de Beausobre, *Nouvelles Considerations sur les Années Climatériques, la Longueur de la Vie de l'Homme, la Propagation du Genre Humain, & la Vraie Puissance des Etats, Considérée dans la Plus Grande Population* (Paris, 1757), 19.

[75] William Derham, *Physico-Theology; Or, a Demonstration of the Being and Attributes of God, from His Works of Creation*, 3rd ed. (London, 1714), 169.

[76] Ibid., 171–78.

[77] Colin Brooks, "Projecting, Political Arithmetic and the Act of 1695," *English Historical Review* 97, no. 382 (January 1982): 31–53.

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meanwhile, later furnished calculations used in framing Queen Anne's Bounty, designed to shore up the livings and public image of the lesser Anglican clergy.[78] Yet as Davenant's definition implied, "Reasoning, by Figures, upon Things relating to Government" might serve either side in political debate; Julian Hoppit is surely right to describe eighteenth-century political arithmetic as a "broad church."[79] Political arithmetic was not the property of any political party. Some of its uses, moreover, had no obvious implications for government at all. Understanding political arithmetic's significance thus means asking not simply what sort of people embraced quantification but rather what the use of numbers might be understood to accomplish in different settings. Here the analytical distinction between secular and sacred political arithmetic becomes important. Anyone might appeal to numbers in secular matters. In sacred contexts, however, the role of empirical observation was less clear and its use more narrowly associated with latitudinarian polemic. Sacred political arithmetic was a "political" science in ways its secular counterpart was not.

This was clearest with respect to biblical history and chronology. Graunt's chapter "Of the Number of Inhabitants" predicted that London's population would double by natural increase in sixty-four years. Applying this "doubling period" to human history, Graunt concluded that Adam and Eve could, in the "5610 Years, which is the Age of the World according to the Scriptures," produce far more offspring than now peopled the planet; "Wherefore," he concluded, "the World is not above 100 thousand years old as some vainly imagine, nor above what Scripture makes it."[80] As we have seen, arguments about the rapidity of ancient population growth had long been used in defense of orthodoxy. What was distinct about Graunt was that he did not simply stipulate a set of assumptions about reproduction that would guarantee rapid doubling. Instead, he clamed to establish such doubling empirically, as a matter of fact attested not by ancient authority but by recent experience. Modern observations of London's growth here supported not only the idea of gradual increase, or even a timetable compatible with scripture in general terms, but also Scaliger's specific calculation of the date of Creation. For the first time, sacred history was justified by quantitative demographic observations made in the present.[81]

For his part, Petty—when pressed by a staunch Calvinist critic, Thomas Barlow—declared "The Mysteries of the Trinity, the Incarnation, and the Resurrection" matters above reason.[82] In freer moments, however, he vindicated the plausibility of bodily resurrection against the jeers of "*Scepticks*" by showing that Ireland alone contained more than enough space for the bodies of all people ever

[78] John A. Taylor, "Gregory King's Analysis of Clerical Livings for John Chamberlayne and the Governors of Queen Anne's Bounty," *Historical Journal* 39, no. 1 (January 1996): 241–48. See Donald A. Spaeth, *The Church in an Age of Danger: Parsons and Parishioners, 1660–1740* (Cambridge, 2000), 30–58.

[79] Hoppit, "Political Arithmetic," 517.

[80] Graunt, *Observations*, 63.

[81] Focusing on Graunt's use of averages, Buchwald and Feingold (*Newton*, 44–106) downplay the significance of political arithmetic; but however flawed, Graunt's use of "doubling periods" to estimate of global population increase represented a new application of empirical methodology to history.

[82] William Petty, "The Scale of Creatures," Osborn Shelves MS fb.135, document 3, f. 8v, Beinecke Library. See Rhodri Lewis, ed., *William Petty and the Order of Nature: An Unpublished Manuscript Treatise* (Tempe, 2012); McCormick, *William Petty*, 224–30.

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born.[83] In letters to his friend (and later president of the Royal Society) Robert Southwell and in print, Petty used observations of variable urban and rural doubling periods to construct a chronology of global demography indexed to events in sacred history, in which periods of doubling gradually lengthened, from 10 years immediately after the Flood to 290 "In *Moses* Time" and 750 "About the Birth of Christ."[84] This was not an optimally "natural" account of demographic history; in varying the doubling periods he used to fit biblical dates, Petty took a "discretionary liberty" that rendered his account merely plausible rather than precise (he took the same approach to secular calculations). Nevertheless, by restricting his discretion to the use of rates of doubling that had been observed, he made consistency with natural history the touchstone of his apologetic. Using current observations of the proportion of "Teeming [i.e., fertile] Women" in a given population, fixing an average ratio of births to deaths by comparing cities and country villages, and allowing for the effects of plagues and other disasters (judged by England's recent experience), Petty sketched a history of population designed "to solve what is written in the Holy *Scriptures* and other *Authentick Books*"—or, as he told Southwell, to "[solve] all the Phenomena of Scripture upon ground Experimentally true."[85]

From the outset, sacred political arithmetic framed empirical observations of present-day demography as independent sources of probable, experimentally justified knowledge about the past. Shifting the epistemological burden of apologetic from biblical exegesis to empirically verifiable natural histories allowed the case for scripture's accuracy to be put to skeptics or atheists in probabilistic terms, compelling the assent of the rational reader. Like other forms of physico-theology, this involved risks as well as benefits, inviting accusations of atheism and opening the door to scientific assaults on scripture. It also involved compromises. Only a prior commitment to a Christian worldview underwrote Petty's particular arrangement of early doubling periods to suit scripture. Less orthodox reconstructions would have been equally legitimate, or equally arbitrary, in purely empirical terms. In other words, sacred political arithmetic suffered from the same ideological constraints that critics identified with natural theology in general.[86] What is interesting is that, notwithstanding these constraints, an avowedly naturalistic, empirically grounded picture of population supplanted assertions of growth derived from the perceived requirements of a given sacred text.

■■■

Political arithmetic's appeal for latitudinarian Anglicans and their allies is not hard to understand. Barbara Shapiro, in particular, has argued that latitudinarians embraced a probabilistic discourse of empirically discoverable "facts" as a way of confuting both radical skeptics and religious "enthusiasts" while avoiding recourse to dogmatism.[87]

[83] Petty to Southwell, 20 August 1681 and 17 February 1682/3, in *PSC*, 92, 115; Petty, *Essays*, 16–25. Letters from September 1685 discuss "full peopling" in relation to scripture; *PSC*, 143–68.

[84] Petty, *Essays*, 25.

[85] Ibid., 22; *PSC*, 115.

[86] See, for example, David Hume, *Dialogues Concerning Natural Religion* (London, 1779); see also Henry St. John, viscount Bolingbroke, *Historical Writings* (Chicago, 1972), 44.

[87] Barbara Shapiro, *A Culture of Fact: England, 1550–1720* (Ithaca, 2000), 163–88; Shapiro, "Early Modern Intellectual Life"; Jacob, *Newtonians*.

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Political arithmetic was such a discourse, so it is not surprising that two giants of the latitudinarian tradition, Stillingfleet and Hale, were among the first to suggest its use in a sacred context—even as they differed over the relative merits of the Hebrew and Greek texts of scripture. Writing in 1662, Stillingfleet engaged La Peyrère on this ground, asserting that if "Arithmetick" could determine the facts of ancient demography, it might reveal the extent of the Flood.[88] Since this left the question open, however, Stillingfleet posited "a more then ordinary *multiplication* of the world from the sons of *Noah* after the *Flood*"—that is, a miracle: "For as *God* had before punished the world by destroying mankind in it by an extraordinary manner; so after the *Flood*, he doth in a particular manner bless *Noah* and his *Sons*, and said unto them, *Be fruitfull and multiply, and replenish the earth*, which may well be thought to have then had an extraordinary effect."[89] In the absence of firmer evidence, the same divine omnipotence that had effected the Flood could account for humankind's recovery.

Stillingfleet's was a very limited first step away from traditional apologetics. As Petty's own work suggested, answering La Peyrère depended less on exact numbers than on the probability that eight people had replenished the earth in relatively short order. As we have seen, defenders of scripture had typically posited what David Livingstone calls a "primitive hyper-fecundity" beyond the capacity of modern people, while also noting the longevity of the patriarchs.[90] For Stillingfleet this fecundity remained miraculous; a special act of providence produced an "extraordinary" and localized effect in Noah and his family. Some thought similarly of biblical longevity, confining it to a virtuous minority.[91] One effect of political arithmetic, in comparison, was to encourage naturalistic accounts of primitive fecundity, in terms of physical (or sometimes cultural) circumstances obtaining in the wake of the Flood. Stillingfleet's dismissal of "Heathen Histories" also became less tenable.[92] Since the authority of scripture was at issue, political arithmetic's apologetic value lay precisely in its epistemological independence of revelation.

A more sustained attempt to exploit this was Matthew Hale's 1677 *Primitive Origination of Mankind*. Like many others, Hale saw in political arithmetic evidence of God's providence. Following Graunt and anticipating Arbuthnot, he noted the order and utility of the sex ratio.[93] He also, like Stillingfleet, disparaged Babylonian, Egyptian, and Chinese challenges to the biblical timeline as "uncertain idle Traditions."[94] But he did not rest there. The propensity of populations to grow steadily over time was not only an index of providence but also a crucial piece of historical evidence against both preadamism and the Aristotelian doctrine of the eternity of the world.[95] If population had always grown, it must have had a beginning; and if

[88] Stillingfleet, *Origines Sacrae*, 556.

[89] Ibid., 556–58.

[90] Livingstone, *Adam's Ancestors*, 53–54; Egerton, "Longevity."

[91] Erasmus Warren, *Geologia; Or, A Discourse Concerning the Earth Before the Deluge* (London, 1690), 273–79; John Beaumont, *Considerations on a Book, Entituled the Theory of the Earth* (London, 1693), 88–97; Robert Miln, *A Course of Physico-Theological Lectures Upon the State of the World, From the Creation to the Deluge* (Carlisle, 1786), 256.

[92] Stillingfleet, *Origines Sacrae*, 1–24.

[93] Hale, *Primitive Origination*, 204.

[94] Ibid., 92.

[95] Ibid., 97–110.

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political arithmetic could establish probable rates of increase for given periods of history—whether or not precise numbers were known—then La Peyrère was vulnerable: "The Inhabitants of the World do daily increase, and their increment surmounts daily their decrease; which could not be, unless the World of Mankind had their original within some proportionate time, and could not consist with such a vast excess of duration which some would assign, much less with an eternal duration."[96] Hale did not think, with Stillingfleet, that a lack of ancient data hampered the application of "Arithmetick" to history. Modern observations furnished a probable account with which to work.

Yet the present could not simply be mapped onto the past without modification. Even if the Bible's authority was not assumed in its own defense, the text of scripture imposed certain restrictions on the application of political arithmetic to the past if that application was to serve any apologetic purpose. The most obvious of these was lifespan: while the few human lives now exceeded eighty years, lives ten times as long were recorded before the Flood, and lives of several centuries' duration even in its wake. For Hale, antediluvian longevity, modestly abridged in the first postdiluvian generations, was crucial to natural explanations of the earth's repopulation: "For considering the long Life of the Ancients that lived within 300 years after the Flood, and consequently their coexistence with those that descended from them; we may without the help of a miraculous fertility find that in 104 years Mankind descended from Noah and his three Sons and their Wives, might arise to a stupendious multitude by that Arithmetical Progression that would be found in their Generations."[97] As a distinctly ancient condition, unknown in modern times, longevity was both an explanatory resource and an epistemological problem. Like the preternatural fecundity it here obviated, it risked turning political arithmetic from a rational proof of scripture into a fig leaf for the arbitrary demands of faith.

A third latitudinarian attempt to bridge secular present and sacred past came with William Bentley's inaugural Boyle Lectures, delivered in 1692 and printed the following year as *The Folly and Unreasonableness of Atheism*.[98] Bentley was Stillingfleet's former chaplain, an avid Newtonian, and one of the preeminent exponents of physico-theology. Confronting eternalism, preadamism, and Epicureanism (which substituted chance for design), he cited Graunt, Petty, Stillingfleet, and Hale in support of his conclusion that the "Opinion of infinite Generations is repugnant . . . to matter of Fact. "Tis a Truth beyond opposition, that the universal Species of Mankind hath had a gradual increase, notwithstanding what War, and Famine, and Pestilence, and Floods, and Conflagrations, and the Religious Profession of Celibacy, and other Causes, may at certain periods of time have interrupted and retarded it. This is manifest from the History of the Jewish Nation, from the account of the Roman *Census*, and Registers of our own Country, where the proportion of Births to Burials is found upon observation to be yearly as Fifty to Forty."[99] Like Hale, Bentley assumed that knowledge of contemporary demographic patterns was applicable to the biblical past, that demographic processes were at least commensurable if

[96] Ibid., 131.

[97] Ibid., 145. See Livingstone, *Adam's Ancestors*, 53.

[98] Richard Bentley, *The Folly and Unreasonableness of Atheism* (London, 1693). See Jacob, *Newtonians*, 162–200.

[99] Bentley, *Folly*, 20.

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not uniform across history, and that providence therefore governed populations through natural, scientifically accessible means. Only on this basis could political arithmetic defend sacred history. Yet no more than Hale or Stillingfleet had Bentley resolved the problem that in crucial respects—fertility and longevity—biblical populations had evidently not resembled modern ones. This difference was part and parcel of the orthodoxy political arithmetic was deployed to uphold; it could not be abandoned but had to be explained. Latitudinarian users of political arithmetic thus faced the dilemma that past and present must be similar enough to be subject to the same science, yet they had to be distinct enough to render natural the demographic differences upon which scripture insisted.

How could one accommodate the facts of political arithmetic to those of the Bible without betraying natural philosophy to dogmatism? Thomas Burnet—a Cartesian philosopher rather than a sacred historian, and an Arian rather than an orthodox Anglican—offered a dangerous but influential answer.[100] Identifying divine providence with the regular operation of nature, the first two books of Burnet's *Theory of the Earth*, printed in English in 1684, defended scripture's general outline by abandoning its philosophical accuracy and treating it (as deists like Charles Blount appreciated) as an allegory tailored to the vulgar.[101] Burnet countered La Peyrère by noting that the "longevity of the first Inhabitants of the Earth seems to have been providentially design'd for the quicker multiplication and propagation of mankind." Indeed, "mankind thereby would become so numerous within sixteen hundred years [roughly the Masoretic figure], that there seems . . . to be a greater difficulty from the multitude of the people that would be before the Flood, than from the want of people" before or afterward.[102] Rather than appeal to miracles, however, Burnet sought to "silence the Cavils of Atheists" by tying longevity to the antediluvian environment, wherein a springlike climate, smooth topography, and fertile soil supported greater numbers and stronger constitutions than the postdiluvian earth could.[103] Providence worked through natural causes, so that "it is altogether as strange a thing that men should have such short lives as they have now, as that they had such long lives in the first Ages of the World."[104] Once the Flood had destroyed this primeval paradise, constitutions naturally weakened and lifespans gradually declined—"[f]or," as Burnet wrote, "every new state of Nature doth introduce a new Civil Order, and a new face and Oeconomy of Humane affairs."[105] Nature's fundamental laws were the same in Petty's time as they had been in Noah's; its specific "Oeconomy," however, had changed.

Burnet's physical hypothesis was scarcely more orthodox than its targets. Yet his exegetical flexibility reflected problems that none committed to the experimental proof of revelation could avoid. In this sense, the Newtonian scholar and mathematician William Whiston's reply, the 1696 *New Theory of the Earth*, fared no

[100] Jacob, *Newtonians*, 32, 61, 106–15; Rossi, *Dark Abyss*, 33–41; Gaukroger, *Collapse*, 32–35.

[101] Thomas Burnet, *The Theory of the Earth* (London, 1684); James Force, *William Whiston, Honest Newtonian* (Cambridge, 1985), 33–40; Levine, *Dr. Woodward's Shield*, 18–47.

[102] Burnet, *Theory*, 22–23.

[103] Ibid., 17.

[104] Ibid., 181.

[105] Ibid., 185.

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better.[106] Whiston knew of political arithmetic through Sussex rector William Nicholls's antideist dialogue *A Conference with a Theist*, also printed in 1696. Nicholls's mouthpiece, Credentius, argued against eternalism "from the Increase of Mankind," conjuring the skeptical Philologus to

> [c]onsider . . . how mightily this Nation of ours has increased within a Century or two; notwithstanding the many Civil and External Wars, and those vast drains of People that have been made into our Plantations . . . how the City of London has doubled it self within these 40 years notwithstanding the last great Plague, and how the Country has increased . . . in a considerable proportion. Now to lay all this together, it is no less than Demonstration, that there has been a gradual Increase of the World for these 3000 Years . . . and that nature inclines still more and more to Augment the stock: so that, tho' we should not grant the World a being from all Eternity, but only suppose it was four or five thousand years before the Mosaical Account; Mankind by this time would have been perfectly wedged together, we should have swarmed every where with nothing but men.[107]

Pressed by Philologus to explain why population might not simply oscillate around a kind of equilibrium, with years of increase followed by "Wars, Famines, and especially Plagues" and "the Eternity of the World" witnessing "successive Increases and Desolations," Credentius delved into classical and modern histories of plague, noting Petty's comments on London's rapid recovery after 1665.[108] Philologus responded by attacking Petty's variable doubling periods ("a perfect Popish Nose of Wax") with vigor: "You make your Periods as you please, and Mankind must either double or treble . . . to serve your Hypothesis. Sir, I believe the Generation, like the Age and stature of Mankind, is governed by a steddy unalterable Law, and is not to be turn'd about to go either fast or slow like a Dukes-Place Clock. I find all of you when you have but a new Hypothesis to advance, will take Nature as well as your Bibles by the Nose, and lead them which way you please, to serve a turn."[109] Faced with the possibility that his science might not bear his argument, Nicholls, like Stillingfleet and Hale, fell back on divine intervention (the "peculiar blessing of Increase given to those first Ages after the Flood") and the authority of "the Mosaical Books."[110]

Whiston agreed with Burnet that "[t]he Inhabitants of the Earth were before the Flood vastly more numerous" than since and that antediluvian longevity was environmentally conditioned.[111] So taken was he with political arithmetic's potential and Nicholls's critique that he devoted a five-page postscript to the dispute, concluding "that, excepting what disturbance extraordinary and uncommon Wars, Famines, Plagues, and such other Merciless destroyers of Mankind of given thereto,

[106] William Whiston, *A New Theory of the Earth, from Its Original to the Consummation of All Things* (London, 1696).

[107] William Nicholls, *A Conference with a Theist* (London, 1696), 68. Nicholls seems to have authored a passage on racial difference (135–49) attributed by Livingstone (*Adam's Ancestors*, 54) to the *Universal History* (London, 1736).

[108] Nicholls, *Conference*, 69–74.

[109] Ibid., 78.

[110] Ibid., 79.

[111] Whiston, *New Theory*, 174–98.

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Mankind have generally increas'd in the same determinate Proportion, and doubled themselves in three hundred and sixty years [Petty's figure for the world's then-current rate of doubling], for more than three thousand years, from the Time of *Moses*, till the present Age."[112]

Accepting Petty's observations but insisting on a less "discretionary" application of them to the past, Whiston sought to improve political arithmetic's methodological consistency and with it the power of the demographic argument against eternalism. But here, like Burnet, he crossed a line that had stopped earlier authors, for, as Credentius conceded, steady doubling periods were inconsistent with specific scriptural claims if not its overall chronology. While Whiston's physical explanation of the Flood was new (he attributed it to the gravitational force exerted by a passing comet), he thus followed Burnet in linking antediluvian fecundity to a distinct environment. For the postdiluvian world—essentially the same as his own—Whiston likewise abandoned scripture's literal truth to defend its chronology in terms of the uniform operation of natural demographic laws. Tainted by Arianism, and eventually driven from Cambridge, Whiston was no straightforward defender of "orthodoxy." Yet in seeking a natural account of early demography to suit scriptural chronology, he faced the same challenges, and looked to the same resources, as his latitudinarian predecessors and successors.

■■■

By 1700, sacred political arithmetic was an essentially apologetic, providentialist, antideist discourse, built on polemical foundations laid by latitudinarians in the 1660s, exploited to the point of heterodoxy by theorists of the earth, and incorporating a growing body of demographic observation and analysis. Despite their dubious reputations among the orthodox, even Burnet and Whiston were seldom if ever blamed for using political arithmetic, though they might be charged with failing to use it properly. Suffolk rector Erasmus Warren's 1690 *Geologia* faulted Burnet's attempt to tie ancient longevity to environmental conditions not only because it lacked "good authority" but also because of the implausible demographic picture that resulted from combining universal, extreme longevity with hyperfecundity and polygamy: "[T]heir Multitudes would have everlaid [*sic*: overlaid] the Earth, and they would have wanted room wherein to subsist." For Warren, "either the Longaevity of the Antediluvians must not be *universal*, or the earth was *incapable* of the *number* of its Inhabitants."[113] On the one hand, although the natural philosopher John Beaumont likewise insisted that such longevity had been "granted only to *Patriarchs* and some few others by a particular Providence" (which took effect alchemically, "through the means of a certain *Panacaea*"), this view was unusual in rational defenses of scripture.[114] On the other hand, with the exception of Newton—who was himself committed to the Masoretic text—overtly heterodox appropriations of demographic observation were seemingly few. Later theorists of the earth such as John Woodward, meanwhile, ignored human multiplication in favor of geological phenomena.[115]

[112] Ibid., 388; Petty, *Essays*, 18.
[113] Warren, *Geologia*, 274, 279–80.
[114] Beaumont, *Considerations*, 95–97.
[115] John Woodward, *An Essay Toward a Natural History of the Earth* (London, 1695).

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Following the lead given by their Restoration predecessors, early eighteenth-century latitudinarian and latitudinarian-influenced apologists came to stress the expression of God's design through the regular operation of physical causes, minimizing (though not altogether excluding) miraculous suspensions of the order of nature.[116] This tendency is striking even in Puritan New England, whence Cotton Mather—a promoter of physico-theology who read Whiston and, more comfortably, Bentley—sent Richard Waller, secretary of the Royal Society, "a Calculation of the possible Increase of the Descendants of *Adam*" in 1712.[117] In "confuting the Cavilling prae-Adamites" and "Deists" for a transatlantic and ecumenical Protestant readership, Mather combined old sources, from Josephus and Pliny to Scaliger and Temporarius. He also used Graunt's findings on life expectancy, and his letter noted contemporary instances of longevity and fertility drawn from colonial experience and natural histories—observations that underscored the natural plausibility of scripture's demographic claims.[118] Nor was this letter a one-off. Mather's massive, unpublished biblical commentary, the *Biblia Americana*, cited "Sir *William Petty*" (really Graunt's *Observations*) on the sex ratio, in the context of an attempt to calculate the population of ancient Israel.[119] Indeed, Mather even used Graunt's life table in several funeral sermons from 1708 onward, citing high rates of infant and child mortality to keep congregants mindful of the precariousness of life.[120] (This pastoral use of political arithmetic may elucidate Mather's promotion of smallpox inoculation in 1720–21—an instance, possibly, of sacred political arithmetic undergirding secular improvements.)[121]

Thus, for latitudinarian and allied defenders of providence and scripture on either side of the Atlantic in the early eighteenth century, political arithmetic served polemical and pastoral functions in manuscript, in print, and in public. Inasmuch as it furnished an enlightened justification for various textual preferences, the antideist discourse of demographic law may sometimes have crossed confessional lines. In 1720, for example, the Irish Catholic priest and scholar Cornelius Nary defended

[116] Even in the early Stuart period, "the line of demarcation between miracles, providences, and prodigious but entirely natural events was very hazy indeed." Alexandra Walsham, *Providence in Early Modern England* (Oxford, 1999), 230. See also Shaw, *Miracles*.

[117] Cotton Mather to Richard Waller, 29 November 1712, EL/M2/33, Royal Society Library, excerpted in Cotton Mather, "An Extract of Several Letters From Cotton Mather," *PTRS* 29 (1714): 71. See Winship, *Seers*, 29–52, 74–110; Kidd, *Protestant Interest*, 1–50; Gregory, "Refashioning"; see also Jeffrey Jeske, "Cotton Mather: Physico-Theologian," *Journal of the History of Ideas* 47, no. 4 (October–December 1986): 583–94. On Mather's physico-theology see Cotton Mather, *The Christian Philosopher*, ed. Winton U. Solberg (Urbana, 1994).

[118] Mather to Waller, EL/M2/33, Royal Society Library; Graunt, *Observations*, 62.

[119] Cotton Mather, *Biblia Americana, Volume 1: Genesis*, ed. Reiner Smolinski (Grand Rapids, 2010), 1017.

[120] For example, Cotton Mather, *Corderius Americanus: An Essay on the Good Education of Children* (Boston, 1708), *Seasonable Thoughts Upon Mortality. A Sermon Occasioned by the Raging of a Mortal Sickness in the Colony of Connecticut, and the Many Deaths of Our Brethren There* (Boston, 1712), and *Life Swiftly Passing and Quickly Ending: A Very Short Sermon, on the Shortness of Humane Life* (Boston, 1716). See Daniel Scott Smith and J. David Hacker, "Cultural Demography: New England Deaths and the Puritan Perception of Risk," *Journal of Interdisciplinary History* 26, no. 2 (Autumn 1996): 367–92.

[121] Mather's stance still puzzles medical historians. See Gareth Williams, *Angel of Death: The Story of Smallpox* (Basingstoke, 2010), 96–126; compare Raymond Phineas Stearns, *Science in the British Colonies of America* (Urbana, 1970), 403–26.

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the "Truth and Probability" of the Septuagint against "Modern Libertins, *Deists*, *Atheists* and *Pre-Adamites*," by which he meant those who used the Masoretic chronology to "make the First Kings of the *Assyrian*, *Babylonian* and *Egyptian* Monarchies to have Reign'd some Hundreds of Years before the Deluge."[122] Among his reasons was the implication "that Noah's three Sons, in the space of 367 Years, should so increase as to People all these Vast and Spacious Countries, and produce so many Millions of Men," an idea that violated both scripture and "the very Nature of Things." This argument, anticipated by Stillingfleet, resurfaced in Anglican controversialist John Jackson's 1752 *Chronological Antiquities*, which decried the Hebrew text's demographic implications as an "Absurdity against the regular and ever uniform Course of Nature."[123]

Successive iterations of this discourse showed a concern with the natural peculiarities of biblical populations that reflected both refinements in secular political arithmetic and complications already noted regarding the uniformity of ancient and modern nature. The extreme longevity of biblical populations, for example, often suggested greater physical strength and stature. In his 1730 *Scripture Chronology Demonstrated*, the staunch High Churchman Arthur Bedford—condemning Newton's revisionist insistence on small postdiluvian populations—repeated Temporarius's suggestion that the stronger and more fecund ancients "might have had Twins every year."[124] But authors more mindful of the "decrements" operating on populations in their own time tried not to overstate the case for ancient population. Richard Cumberland, Tillotson's protégé and later bishop of Peterborough, supposed that ancient couples might have begun reproducing at age twenty, producing one child each year, male and female births alternating. This would rapidly produce a population in excess of biblical requirements. Yet, as he wrote in *Origines Gentium Antiquissimae* (printed posthumously in 1724), "[A]ll this surplusage, and all their issue in every succession we reckon not in our table, but give in liberally to compensate all later marriages, barrennesses, and casual deaths which can't be accounted for, and to the same end we reckon upon no births of twins. . . . To add to our compensation of casualties, we reckon of no births within less time than a full year."[125] Having demonstrated that "great numbers of men were possible," Cumberland left it to future historians to show "great numbers actually to have been."[126] Petty, who had emphasized that his own numbers were probable measures of "natural possibility" rather than precise assertions of positive fact, could hardly have put it better.[127]

Norfolk rector Samuel Shuckford's three-volume *Sacred and Prophane History of the World Connected* (1728–37), a monument to latitudinarian exegesis and Enlightened euhemerism, imaginatively traced the natural effects of biblical

[122] Cornelius Nary, *A New History of the World* (Dublin, 1720), 30.

[123] John Jackson, *Chronological Antiquities*, 3 vols. (London, 1752), 1:50.

[124] Bedford, *The Scripture Chronology Demonstrated by Astronomical Calculations* (London, 1730), 205[b]. See Isaac Newton, *The Chronology of the Ancient Kingdoms Amended* (London, 1728); Scott Mandelbrote, "Bedford, Arthur (*bap.* 1668, *d.* 1745)," in *Oxford Dictionary of Natiopnal Biography* (Oxford, 2004), online edn., http://www.oxforddnb.com/view/article/1927 (accessed July 22, 2012).

[125] Richard Cumberland, *Origines Gentium Antiquissimae* (London, 1724), 148.

[126] Ibid., 156.

[127] William Petty, *Political Anatomy*, 26.

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demography.[128] One result was an explanation of the "Confusion of Tongues" in terms of "The gradual Decline of Men's Lives, from longer to shorter Periods": "for when Men's Lives were long, and several Generations lived together in the World . . . they could not but transmit their Language thro' many Generations with but little Variation: But when the Successions of Mankind came on quicker, the Language of Ancestors was more liable to grow Obsolete, and there was an easier Opportunity for Novelty and Innovation to spread amongst Mankind. And thus the Speech of the World, confounded first at *Babel*, received in every Age new and many Alterations."[129] The Arian Robert Clayton, Church of Ireland bishop of Clogher, took an even more directly political-arithmetical approach to the question. The dispersion from Babel, he argued, was both a divine chastisement and an effect of population pressure on the land.[130] Considering the heroic childbearing careers open to women whose lives spanned several centuries, he grounded his speculation in a proportionality between ancient and modern life cycles, "since Women, at present . . . frequently bear Children after they are fifty Years of Age, and seven hundred bears near the same Proportion to nine hundred and fifty as fifty does to seventy."[131] He even applied to Noah's wife and her fellows the telltale political-arithmetical term for women of childbearing age: "breeders."[132]

As Clayton's presumption of proportionality but not identity between ancient and modern demographic patterns suggests, attempts to establish the reasonable nature of computations prompted thinking about what assumptions were "reasonable" given what was known about the ancients on one hand and nature's economies on the other. In his *Enquiry into the Truth and Certainty of the Mosaic Deluge* (printed in 1750, a year after his death), Scottish Episcopalian clergyman Patrick Cockburn allowed that "as the birth of Twins is not so very rare even in our days, it might probably be more frequent at first, when human nature was vigorous and healthful, as by their long lives appears." "For the same reason," he thought, "we may reasonably suppose that few children died in their infancy, whereas now numbers do every year."[133] But ancient longevity made it unreasonable to assume that the patriarchs "began to propagate their kind as early" in life as at present or (since the "time allotted to the nursing of Infants" was likely longer) "that the women brought forth children every year."[134] On the contrary:

> The several stages of human life . . . commonly bear a proportion to the whole term of life. . . . In the *Antediluvian* World then, when men lived to upward of eight hundred and nine hundred years, can it be thought that they passed through the several stages of life in as short a time as men do now, who seldom exceed eighty[?] [T]hen would the several stages of human life have been lost or confounded, and men would have started from childhood to manhood at once, without any due or regular intervals,

[128] Samuel Shuckford, *The Sacred and Prophane History of the World Connected*, 3 vols. (London, 1728–1737); Arnold, "Learned Lumber," 1144–45; Preston, "Biblical Criticism," 101.

[129] Shuckford, *History*, 1:140.

[130] Robert Clayton, *The Chronology of the Hebrew Bible Vindicated* (London, 1747), 53.

[131] Ibid., 51.

[132] Ibid., 52. See Graunt, *Observations*, 45; William Petty, *Observations Upon the Dublin-Bills of Mortality, MDCLXXXI* (London, 1683), 2; Jonathan Swift, *A Modest Proposal* (Dublin, 1729), 9, 11–12.

[133] Patrick Cockburn, *An Enquiry into the Truth and Certainty of the Mosaic Deluge* (London, 1750), 92.

[134] Ibid., 80–90.

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> contrary to the order of nature. But if according to the present Oeconomy of nature, man is but a youth at twenty, which is a fourth part of our term of life, we may reasonably conclude, there would be a suitable proportion of years in a much longer term of life, since Nature is constant and uniform in her operations.[135]

A later Boyle lecturer, William Worthington, went even further, pointing out that "[t]he period of gestation might not have been the same, in the old world, as in this"—yet another reasonable caution against overconfident assertions of ancient fecundity.[136]

While Cockburn's presumption of a proportionality between corresponding stages of life among ancients and moderns led him, like Stillingfleet and later Jackson, to champion the Septuagint, his emphasis on the analytical significance of such stages followed a lead given by Petty and others studying modern populations.[137] (Even an opponent of Cockburn's based his criticism on an alternative proportionality between maturation and physical size: "Naturalists agree," wrote Philip Howard in 1797, "that parrots, ravens, and eagles" outlive humans, "and yet we do not perceive that they attain their full vigor much later than other birds of the same size." Thus "Man, when he lived 400 years, might be stronger . . . but we cannot reasonably suppose that the age of manhood was more than 25 in climates where it is now at 15.")[138] Whichever text was favored, and whether Genesis was taken literally or as a vulgarized but not false account of early history, population was the product of a network of divinely installed natural proportions whose measurement would elucidate the biblical past and providential oversight in the present.

■■■

In a sense, such aims were increasingly marginal to the mainstream of mid- and later eighteenth-century secular political arithmetic, which was taken up with fiscal policy, public health, and the ever more refined calculation of annuities. While the Anglican clergy was still well represented among commentators on population, moreover, rational Dissenters like Richard Price and deists like Benjamin Franklin were at the forefront of new developments. Quantitative discussions of population were more likely to fuel projects for hospitals or pension schemes than defenses of Mosaic history. It is tempting to see the mid-eighteenth century as the moment that demographic quantification was definitively secularized, its sacred historical applications retreating under fire from Voltaire and Hume even as its scientific pretensions were superannuated by French and Scottish political economy. Sacred political arithmetic, having attracted some of the best minds of the Restoration and early Enlightenment, persisted after 1750 as the hobbyhorse of cranks.

[135] Ibid., 61–62.

[136] William Worthington, *The Scripture-Theory of the Earth* (London, 1773), 210–11. Compare, however, Thomas Newton, *The Works of the Right Reverend Thomas Newton, D.D. Late Lord Bishop of Bristol, And Dean of St. Paul's, London* (London, 1787), 157.

[137] William Petty, *The Discourse . . . Concerning the Use of Duplicate Proportion in Sundry Important Particulars* (London, 1674), 82–88; McCormick, *Petty*, 217–20.

[138] Philip Howard, *The Scriptural History of the Earth and of Mankind* (London, 1797), 162. This made sense of Sarah's pregnancy (see Genesis 17:16–19 and 18:10–19) at the age of 90—rather *young* for proponents of late puberty.

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There is an element of truth to this. Sacred political arithmetic never overcame the fundamental dilemma its first users had faced—namely, that their exploitation of population's natural history was compromised by their very commitment to sacred history. This was arguably a variation of the larger dilemma facing contemporaneous forms of natural theology, which Hume skewered in his *Dialogues Concerning Natural Religion*. It is thus fitting that Hume should also have undercut demographic defenses of sacred history in his 1752 essay "Of the Populousness of Ancient Nations," which simply dismissed the Bible—and indeed all numbers quoted in ancient sources—as unreliable.[139] Men like Cockburn could refine their models of biblical demography by analogy with what was known of modern populations, but while this might inform their exegesis, it brought them no closer to direct knowledge of the past outside of scripture. Meanwhile, new theories of social development anticipated by Newton and elaborated by Montesquieu, Hume, and others shifted attention from dubious numbers to the predictable effects of morals, institutions, and modes of subsistence—factors for which more reliable evidence was available.[140] At the same time, new trends in English and German Protestant hermeneutics transformed the Bible itself from a definitive history of humanity into an archive of ancient beliefs—a cultural document.[141] In a roundabout way, La Peyrère had won.

By comparison with secular statistics, theories of civilization, or historical biblical criticism, sacred political arithmetic after 1750 was a stalled enterprise. By themselves, however, such comparisons neither explain its decline nor reduce its significance. Despite the temptation to invoke the process of secularization so long associated with the Enlightenment in accounting for sacred political arithmetic's marginalization, a couple of observations are worth making. The first is that changes in English religious life may simply have made this discourse less relevant. As the threat of radical deism receded after the early eighteenth century, Anglican apologists were confronted not so much by philosophical challenges to doctrine as by popular stirrings of inward spirituality. Against such awakenings, probabilistic natural philosophy and naturalistic exegesis ceased to be powerful weapons. A second observation is that although there was a real distinction between sacred and secular political arithmetic, the distance between them looks larger in retrospect than it did at the time. Through the 1750s, Derham's *Physico-Theology* was among the works most commonly cited by political arithmeticians working on secular questions, many of whom were both clergymen and amateur natural philosophers.[142] While sacred political arithmetic lost some of its applications, therefore, the broader historical and providential understanding of population that it reflected seems likely to have survived.

[139] David Hume, *Essays Moral, Political, and Literary*, ed. Eugene F. Miller (Indianapolis, 1987), 377–464; Arnold, "Learned Lumber," 1164–65.

[140] See Charles-Louis de Secondat, baron de Montesquieu, *Lettres Persanes* (Cologne, 1754), 88–119; Buchwald and Feingold, *Newton*.

[141] Jonathan Sheehan, *The Enlightenment Bible: Translation, Scholarship, Culture* (Princeton, 2005).

[142] See Kersseboom, *Essais*, 38; William Brakenridge, "A Letter . . . concerning the Number of People in England," *PTRS* 49 (175–56): 275; William Brakenridge, "A Letter... Containing an Answer to the Account of the Numbers and Increase of the People of England," *PTRS* 50 (1757–58): 472; Richard Forster, "An Extract of the Register of the Parish of Great Shefford, Near Lamborne, in Berkshire, for Ten Years: With Observations on the Same," *PTRS* 50 (1757–58): 358. See also Glass, *Numbering*, 11–40, 47–77.

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In this light, a fitting example with which to conclude is the Sheffield physician Thomas Short. The author of three substantial and widely cited works of medical arithmetic between 1749 and 1767, Short exemplified the tendencies now seen as central to the growth of Enlightenment human science: a concern with the health of the population and with the effects of industry and the physical environment upon it, a dogged pursuit of reliable demographic data, and a distillation of experimental and statistical research into metropolitan and colonial policy.[143] Yet in a 1750 shortlist of major works of political arithmetic he included Derham's *Physico-Theology*; the only work of Petty's mentioned was the 1674 *Discourse Concerning the Use of Duplicate Proportion*, a mixed-mathematical tract that considered life expectancy alongside corpuscularian matter theory.[144] Like Petty, Short saw political arithmetic in natural-philosophical terms, as offering an empirical basis for comparing "the Hippocratical, Galenical, Paracelsian, Willisian, Sylvisian, Helmontian, and Mechanical" systems.[145] He also made much of the providential traces demographic records revealed. Analyzing London and Dublin births and burials between 1666 and 1746, Short noted as "surprizing Instances of kind Providence" the facts that years cruel to adults spared children and vice versa, that the virulence and transmission of certain "Mortalities" indicated a design to produce specific moral effects, and that "[t]hough [God's] Mercies are often general, yet his Judgments are rarely such."[146] For this enlightened practitioner, demography remained a sphere of divine trial and mercy, the punishment of vice and the reward of virtue.

It remained tied, too, to a biblical past. The very benefits of rural life, made clear in the mortality bills, underlined its "Image or Resemblances of the primeval State."[147] Moving from medical arithmetic to history, Short devoted a section of his 1750 *New Observations* to "the Increase and Numbering of the Israelites," surveying disputes over chronology and concluding, on the strength of extrapolations from scriptural figures for the adult male population, that the descendants of Abraham had doubled their numbers in Egypt every fifteen years.[148] Short was aware that "[t]his uncommon Increase seems surprizing to us at this Distance of Time, when human Life is much abbreviated, Constitutions weakened," and "our Climate, Country, and Way of Life, all so different from theirs." Yet the Israelites' "Advantages" had included the divine promise of fertility, the natural effects of longevity, and the rarity of "Abortion or Barrenness" and "improlific deaths"; "they buried not their 33, 46, or 57 *per Cent. impuberes* as we do," he concluded, "nay not one."[149] If Short differed from "religious" authors such as Cockburn, it was not only in his superior grasp of current

[143] Thomas Short, *A General Chronological History of the Air, Weather, Seasons, Meteors, &c. in Sundry Places and different Times*, 2 vols. (London, 1749), *New Observations*, and *A Comparative History of the Increase and Decrease of Mankind in England, and Several Countries Abroad* (London, 1767); Rusnock, *Vital Accounts*, 143–72.

[144] Short, *New Observations*, xi–xii.

[145] Ibid., 13.

[146] Ibid., 236–41.

[147] Ibid., 1.

[148] Ibid., 249–57.

[149] Ibid., 259–61.

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statistics but also in his more confident invocation of providence as a driver of demographic change.

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What of Malthus? The first *Essay on the Principle of Population* was printed in 1798, long after the vital period of sacred political arithmetic.[150] Its origins lay in French and Scottish political economy, and its targets were not deists or preadamites but adherents of Godwin and Condorcet, who hoped not only to revolutionize society but also to transcend nature itself.[151] To see "Parson Malthus" as the direct heir of Hale, or even of Petty, ignores context and strains credibility. But to deny any relationship between the clerical "father" of modern demography and the major native strand of demographic thought that preceded him seems hardly more plausible. In fact, anticipations of "Malthusian" language abound in latitudinarian adaptations of political arithmetic, from the notion of "Geometrical Progression" to the effects of pressure on limited resources to the inevitability of external "Prunings" or "Correctives" to growth.[152] More substantive than such isolated echoes, however, is their embedment in a providential framework of population management—a framework anchored ultimately, though by Malthus's time only obscurely, in sacred historiography.

Demographic catastrophe had been seen by Derham, as by Short, to serve natural and moral purposes simultaneously, "not only a just Punishment of the Sins of Men, but also a wise Means to keep the Balance of Mankind even."[153] Periodic culls of overpopulated areas by plague, war, or other means chastised human transgressions while keeping numbers within supportable bounds. What was this, Derham had asked, "but admirable and plain Management? What can the maintaining throughout all Ages and Places these Proportions of Mankind . . . this Harmony in the Generations of Men be, but the Work of one that ruleth the World!"[154] Cockburn and others made a similar point about the Flood, arguing that the ensuing "abridgment" of the human lifespan represented both an inevitable adjustment to earth's physical upheaval and a much-needed check to human pride.[155] In light of these discussions, the legacy of sacred political arithmetic is discernible in Malthus's own conclusion that "[t]he principle, according to which population increases, prevents the vices of mankind, or the accidents of nature, the partial evils arising from general laws, from obstructing the high purpose of creation. It keeps the inhabitants of the earth always fully up to the level of the means of subsistence; and is constantly acting upon man as a powerful stimulus, urging him to the further cultivation of the earth, and to enable it, consequently, to support a more extended population."[156] Waterman and Winch have explored Malthus's ties to the physico-theology of

[150] Thomas Robert Malthus, *An Essay on the Principle of Population, As It Effects the Future Improvement of Society* (London, 1798).

[151] Waterman, *Revolution*, 15–112.

[152] Each appears in Hale's *Primitive Origination*; see "Sir Matthew Hale."

[153] Derham, *Physico-Theology*, 177.

[154] Ibid., 178.

[155] Cockburn, *Enquiry*, 57. See also Benjamin Parker, *A Review of the State of the Antediluvian World* (London, 1748), 51–52.

[156] Malthus, *Essay*, 365.

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William Paley's day. Yet the foregoing account suggests that components of this counterrevolutionary discourse took shape over a century earlier, in the antideist polemics and philosophical sermons of the scientific revolution and the early Enlightenment.

Political arithmetic's religious career undermines any simple connection between the quantitative, naturalistic conceptualization of population and the rise of either an economistic worldview or a biopolitical state. That is not to say that the latter did not occur. It is instead to suggest that the history of demographic thought tells us more about eighteenth-century politics and culture if we recognize the limitations of approaches organized around the emergence of modern disciplines, institutions, and worldviews. Even when imagined as a quantifiable entity accessible to political and economic management, population was never a purely secular concept. Its history was seen to reflect humankind's relationship to God in an economy of nature explicitly framed to teach moral lessons; demographic patterns and events were fodder for pious broadsides and sermons to congregations large and small from London to Boston. The very process by which population became an object of scientific attention—a process tied to epidemics in London and colonial politics in Ireland, but also to the reception of Baconian natural history in the Hartlib Circle and the Royal Society—reinforced its religious significance, just as the data used ensured the involvement of the Church of England. Before political economy or the information state, the sacred history and providential meaning of human multiplication made population central to the Enlightenment in England and beyond.

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